Insights from In-situ Measurements of Black Carbon during the Marine Stratus Experiment.

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As part of DOE's marine stratus experiment (MASE) field campaign in Marina, CA a photoacoustic (PA) aerosol absorption instrument was deployed on the CIRPAS (Center for Interdisciplinary Remotely Piloted Aircraft Studies) Twin Otter during July 2005. The aim of these measurements was to elucidate aerosol processes regulating marine stratus clouds. Marine stratus play a dominant role in the Earth's radiative balance and improved stratus microphysical parameterizations are needed to quantify indirect effects of anthropogenic aerosols on climate. In particular, the effects of black carbon on clouds physical and optical properties are still poorly understood, and in-situ, real-time measurements can be used to improve our physical and chemical understanding.

The PA instrument developed at the Desert Research Institute of Reno, NV was installed on board the Twin Otter airplane and flown over the Pacific Ocean near Monterey, CA in proximity of the California coast, where marine stratus are a common occurrence. The instrument measured simultaneously aerosol absorption and ~180° integrated scattering at 870nm. The aircraft carried other instrumentation that measured microphysical and chemical properties of aerosols and clouds.

We report here a preliminary analysis of absorption and scattering measurements together with data from other on-board instruments. The aerosol absorption was often low and indistinguishable from instrumental noise (~0.6 Mm^{-1} for 2 minutes averages), indicating clean conditions resulting from the offshore flow and an extensive marine stratus deck. However, we sampled interesting short-term events with higher absorption and scattering values during almost every flight. Often these episodes were related to ship tracks and/or anthropogenic pollution from land. Our simultaneous measurements of absorption and scattering yielded a single scattering albedo (SSA) of about 0.75 to 1, which is consistent with previous studies. SSA values can give information regarding the mixing state of the aerosol sampled, while functional relations between SSA and absorption can yield information regarding plume dilution and ambient air entrainment.

Some of the instruments carried by the aircraft, such as a Particle Soot Absorption Photometer (PSAP), were run downstream of a Counterflow Virtual Impactor (CVI) in cloud. By combining data from PA and PSAP instruments when the CVI was on, we can deduce the distribution (cloud drop and interstitial fraction) and optical properties of black carbon containing particles inside the cloud. In at least one episode the higher absorption and scattering values appeared to be related to aerosols with high levels of inorganic mass, especially sulfate. An on-going comparison with data from an Aerodyne aerosol mass spectrometer and a particle-into-liquid sampler, also onboard the plane,

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should help us to understand the chemistry and physics of indirect effects of black carbon containing aerosols on marine stratus.